Improving Confidence in Long-Term Dose Assessment for U-238 Series Radionuclides

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Many organisations have an interest in the long-term radiological impacts of environmental releases of U-238 series radionuclides. Particular interest arises because of the very long half lives and radiation dose contributions of some of the radionuclides involved. These half lives are much longer than the stability of near-surface environments and the likely period of effectiveness of engineered barriers in shallow disposal concepts. The half lives are also significant in relation to the containment that can be provided by deep geological disposal concepts. The issues associated with modelling the behaviour of U-238 and its progeny in the near-surface geosphere and biosphere are therefore of interest in relation to solid radioactive waste disposal, but are also of interest in relation to uranium mining and milling legacies and management of wastes from NORM industries. There is commonly a need to consider the full U238 decay chain, or at least several members of it, in order to fully address disequilibrium and migration issues, including radon emanation in different environmental situations.

In 2010, the international BIOPROTA forum (www.bioprota.org) established a working group to investigate the assessment of U-238 series radionuclides in terrestrial ecosystems. Participants include: Andra, CIEMAT, the UK Food Standards Agency (FSA), IRSN, NDA

RWMD, NRPA, NUMO, NWMO, SKB, the University of Bremen and University of Lausanne (CHUV).
The current phase of work is focussed on the U-238, U-234, Th-230 and Ra-226 chain members. Building upon work carried out by the International Union of Radioecology, interaction matrices of the system features, events and processes (FEPs) have been developed for each of these radionuclides. Seven models have been identified for auditing against the FEP interaction matrices as part of an initial qualitative model inter-comparison, these models are: (i) the soil redox model used by CIEMAT, (ii) Andra's multi-layer near surface transfer (SAMM) model, (iii) NDA RWMD's current Biosphere Assessment Tool, (iv) RESRAD-OFFSITE, (v) the model used in remediation projects by Wismut GmbH, (vi) NWMO's SYVAC3-CC4 model and (vii) the FSA's PRISM model.
As part of a subsequent quantitative model inter-comparison, a subset of these models was applied to calculate the concentrations of U-238, U-234, Th-230 and Ra-226 in a soil profile and in the edible parts of the harvested crops as a result of the upwelling of contaminated water. This degree of contamination of this upward flux is based upon empirical measurements of the concentrations of these radionuclides in the Maderos River, near the Los Ratones uranium mine site, south west Spain (Agüero et al. [1]). Soil properties, including texture and distribution coefficients, and soil-plant transfer factor data used in this study have also been derived from empirical data collected in the vicinity of the Los Ratones mine (e.g. Vera Tomé et al. [2]). Results from these analyses are presented, together with a discussion of interpretation of site data, and implications for improving confidence in long-term dose assessments for U 238 series radionuclides.

References

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